

Progress Report for the proposal titled "ERBE AND SAGE-II INVESTIGATIONS OF  
CLOUD RADIATIVE FORCING IN THE TROPICS: THE EFFECTS OF CLOUD TYPE  
AND CLOUD OPTICAL PROPERTIES"

NASA REFERENCE NUMBER : 2445-MD/ER-0009

NASA GRANT NUMBER : NAGW 3966

OUR RESEARCH PROPOSAL NUMBER : 92-28

7N-47-013  
55485

SUBMITTED BY:

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to

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NASA Mission to Planet Earth

Science Division, Code YS

Radiation Science Program

National Aeronautics and Space Administration

Washington D.C 20546

## 1. Research activities

The goal of this investigation is to gain a thorough understanding of the radiative contributions of tropical cloud systems and their optical and microphysical properties.

In the report of the last period, the results from six months of data processing were discussed. These results now have been submitted as journal publications. A paper entitled "AVHRR and ERBE Investigations of Cloud Radiative Forcing in the Tropics Part I: The Effect of Cloud Optical Properties and Scene Identification" has been submitted to the Journal of Geophysical Research. Another paper entitled "Radiative Forcing of Large Scale Cloud Systems Over Mid-Latitude Oceanic Regions" also has been submitted to the Journal of Geophysical Research. The paper titled "Observations of the Global Characteristics and Regional Radiative Effects of Marine Cloud Liquid Water" was published in the J. Climate, Vol 8, No12, December 1995, pages 2928-2946. This work was done in collaboration with researchers at the Department of Atmospheric Science in Colorado State University. Copies of all three papers are attached.

We have been testing our algorithms for viewing geometry effects on scene identification and optical property retrievals. A preliminary study on the role of Sea Surface Temperature in modulating cloud optical properties also was completed.

## 2. Results:

### *2.1 The effect of cloud optical properties on SST*

One of the goals of this study is to compare the role of cloud optical properties in modulating the SST in the tropics. The NOAA operational algorithm is used to derive SSTs for 1985, and the ISCCP CX SST's are used for 1987. Figure 1 shows the SST distributions for the region of interest. Figure 1a shows the SST distribution for April 1985 which represents a non El Nino year, and Figure 1b shows the Western Pacific, with maximum values of about 29°C around the equator. The Central Pacific in 1985 is relatively cooler with maximum values around 25°C. Due to sampling problems, note that no SST values were obtained for pixels that are colored white in Figure 1a. Figure 1b shows the

APR 1985 20 (0.5 x 0.5)

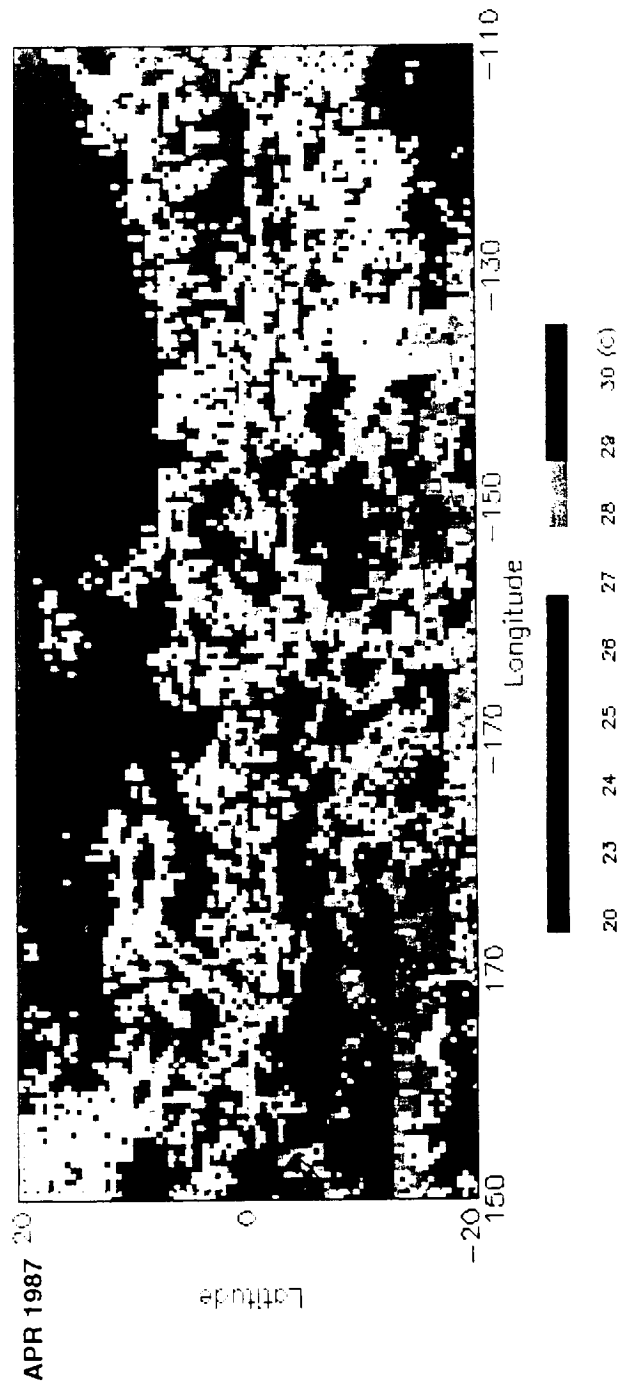
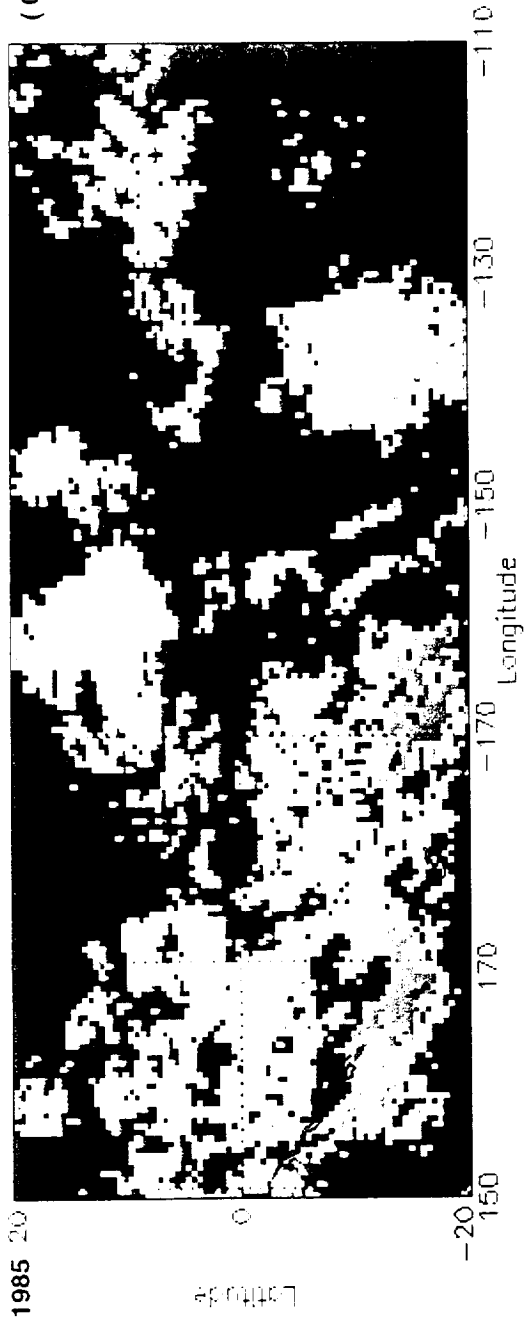


Fig. 1 Sea surface temperature for a) April 1985 b) April 1987

dramatic changes in SST for the El Nino year. Changes of up to 5 to 6 degrees can be seen along the equatorial belt due to the transport of warm waters from the Western to the Eastern Pacific. The Central Pacific is considerably warmer with peak values reaching around 29 to 30° C. The SSTs that were obtained at this resolution were compared to the 2.5°× 2.5° gridded Multi Channel Sea Surface Temperatures (MCSSTs) that are commonly used for climate studies. While the distribution of SSTs between the MCSST and the SSTs derived from this study are qualitatively similar, the magnitudes differ by as much as 2°C in certain areas of the tropics. Since the SST's derived from this study are from a higher spatial resolution and derived on an image -to- image basis,, they are representative of the synoptic conditions under consideration and, are therefore used in the analysis.

In order to how examine the relationship between SST and cloud optical properties varies between 1985 and 1987, the changes in SST values between 1987 and 1985 (DSST) are plotted as a function of cloud optical properties in Figure 2. Figure 2a shows the number of pixels for each DSST bin category. Maximum frequencies are found for pixels with DSST values between 1 to 2°C, with about 900 pixels having values between 2° to 4°C, 300 pixels between 4° to 6°C and about 50 pixels in the 7° to 8.0°C range. Only two pixels are found between 10° and 12°. Figure 2b shows the correlation between change in SST (DSST) values and changes in cloud optical thickness values between 1987 and 1985. The data are gridded in 1° intervals. For each degree change in SST, the difference in cloud optical thickness (DTAU) value is determined at each grid box. The majority of the DTAU values are positive, which shows that SST values increase with increasing values of cloud optical thickness. All pixels whose DSST values are positive have positive DTAU values. This shows that the warmer El Nino event of 1987 produces thicker clouds. The change in effective radii values (DRE) in Figure 2b shows that positive DSST changes have negative DRE changes. The values at DSST 10° C and 11° C have one grid box value and therefore should not be considered. Figure 2c shows the correlation between changes in ice water path (DIWP) between the two years and DSST values. Positive DSST changes are correlated with positive DIWP values,

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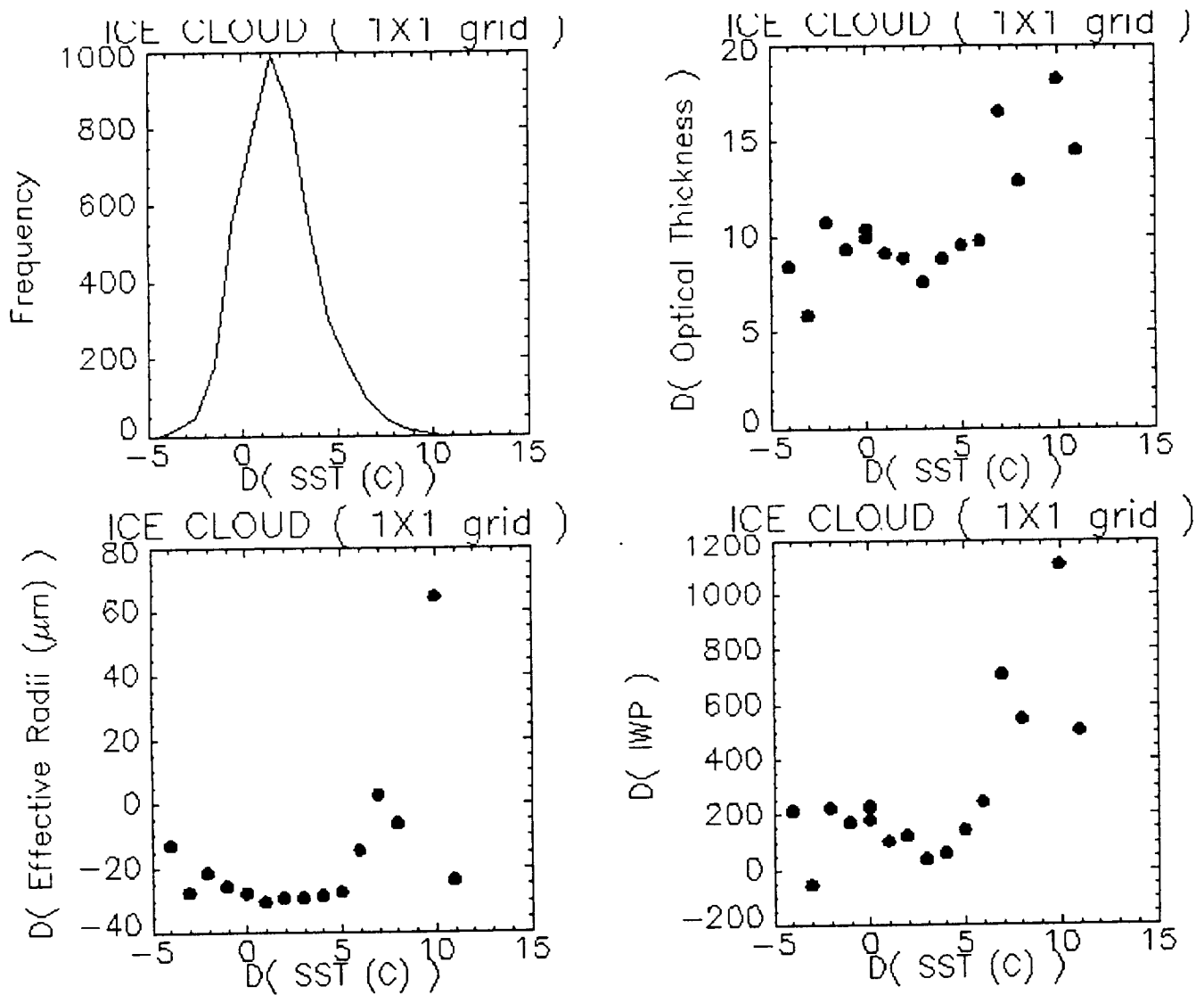


Fig. 2 Correlation between SST differences and a) Frequency b) differences in cloud optical depth c) effective radii and d) ice water path between 1987 and 1985

for each DSST e SST for 1987 which represents an El Nino year. Several interesting features can be noted from these figures. April 1985 shows warmer temperatures in the Western

### 3. Future Work

Much of the future work will be directed towards more data processing. Collocated AVHRR and ERBE analysis will be performed for the 1985 and 1986 time periods.

### 4. Publications:

Greenwald, T. J, G. L. Stephens, **S. A. Christopher** and Thomas H. Vonder Haar, 1995: Observations of the Global Characteristics and Regional Radiative Effects of marine Cloud Liquid Water, *J. Climate*, 8(12) , 2928-2946.

**Christopher, S.A.**, J. Chou, A. Vander Vorste and R.M. Welch, 1995: AVHRR and ERBE Investigations of Cloud Radiative Forcing in the Tropics Part i: The Effect of Cloud Optitlca Properties and Scene Identification, submitted to J. Geophysical Research.

Li, X., **S.A. Christopher,S.A.**, and R.M. Welch, 1995: Radiative Forcing of Large Scale Cloud Systems Over Mid-Latitude Oceanic Regions, submitted to J. Geophysical Research.

**Christopher, S.A.**, A. Vander Vorste, S. E. Watters and R. M. Welch, 1994: Cloud radiative forcing in the tropics: The effect of optical property retrievals and scene identification. Proc. 8th Conf. on Atmos. Radiation, Nashville, TN, 451-452.

**Christopher, S.A.**, J. Chou, A. Vander Vorste, and R. M. Welch and T. H. Vonder Haar, 1994: The effect of cloud optical properties on cloud radiative forcing in the tropics. Proc. SPIE European Symposium on Satellite Remote Sensing, 26-30 Sep 1994, Rome, Italy.

**Christopher, S. A.**, J. Chou, A. Vander Vorste and R. M. Welch, 1995: The effect of cloud optical properties on sea surface temperature in the tropics. Proc. fourth Conf. on Global Change Studies, 15-20, Jan 1995, Dallas, TX, Amer. Meteor. Soc.

PROPOSED BUDGET  
Year Three  
Period: 1 May 1996-30 April 1997

	College Fiscal Year -----	Effort in Man-Mo -----	Monthly Salary Rate* -----	AMOUNT REQUESTED BY PROPOSER -----
A. SALARIES AND WAGES:				
1. Co-Principal Investigator				
R.M. Welch	1996	0.10	\$7,832	783
	1997	0.40	\$8,067	3,227
2. Co-Principal Investigator				
S. Christopher	1996	1.00	\$3,914	3,914
	1997	3.00	\$4,031	12,093
3. Programmer				
D.V. Klicke	1996	1.50	\$3,095	4,643
	1997	6.50	\$3,188	20,722
				-----
Subtotal				\$45,382
C. FRINGE BENEFITS:				
1. For staff personnel, @ 19.0% of Salaries & Wages				8,623
				-----
Subtotal				\$8,623
TOTAL SALARIES, WAGES, AND BENEFITS:				\$54,005
D. PERMANENT EQUIPMENT:				\$0

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\* Salary rates for staff include a vacation accrual adjustment.



AMOUNT  
REQUESTED  
BY PROPOSER  
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E. TRAVEL:

1. One trip to present paper at a scientific conference	
a. Airfare	900
b. Per diem, Lodging, 5 nights @ est \$80/night	400
Meals, 6 days @ \$27.50/day	165
c. Surface transportation and Misc.	85
	-----
Subtotal	1,550
2. Travel to ERBE Meetings(2)	
a. Airfare, 2@ \$800ea	1,600
b. Per diem, Lodging, 3 nights @ \$80/night*2 persons	480
Meals, 4 days @ \$27.50/day* 2 persons	220
c. Local transportation	200
	-----
Subtotal	2,500
Total travel	\$4,050

G. OTHER DIRECT COSTS:

1. Materials and Supplies	
a. Computer tapes and software	1,000
b. Data	1,200
c. Books, manuals, & reproduction	1,200
	-----
Subtotal	\$3,400
2. Publication Costs/Page Charges	
a. Paper in scientific journal	1,520
b. Conference paper	400
	-----
Subtotal	\$1,920
3. Other	
a. Long distance telephone calls	360
b. Conference registration fees	165
c. Computer and Software Maint.	359
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Subtotal	\$884
Total Other Direct Costs	\$6,204
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H. TOTAL DIRECT COSTS:

\$64,259

I. INDIRECT COSTS: @ 43.5% of Total Salaries and Wages

\$19,741

J. TOTAL COSTS:

\$84,000

## CERTIFICATION REGARDING LOBBYING

### Certification for Contracts, Grants, Loans, and Cooperative Agreements.

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000, and not more than \$100,000 for each such failure.

Sharon L Reid  
Signature and Date

03/08/1996

Timothy G. Henderson, Director of Business & Administration  
Name and Title of Authorized Representative

South Dakota School of Mines & Technology  
Organization Name

## Certification Regarding Drug-Free Workplace Requirements Grantees Other Than Individuals

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This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or governmentwide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

This grantee certifies that it will provide a drug-free workplace by:

- (a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
- (b) Establishing a drug-free awareness program to inform employees about -
  - (1) The dangers of drug abuse in the workplace;
  - (2) The grantee's policy of maintaining a drug-free workplace;
  - (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
  - (4) The penalties that may be imposed upon employees for drug abuse violations in the workplace;
- (c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);
- (d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will -
  - (1) Abide by the terms of the statement; and
  - (2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;
- (e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction;
- (f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted -
  - (1) Taking appropriate personnel action against such an employee, up to and including termination; or
  - (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;
- (g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraph (a), (b), (c), (e), and (f).

South Dakota School of Mines & Technology

NAGW-3966

Organization Name

PR/Award Number or Project Name

Timothy G. Henderson, Director of Business & Administration

Name and Title of Authorized Representative

*Sharon L Reid for:*

Signature

*03/08/1996*

Date

Certification Regarding  
Debarment, Suspension, and Other Responsibility Matters  
Primary Covered Transactions

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This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160-19211). Copies of the regulation may be obtained by contracting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, DC. 20202-4725, telephone (202) 732-2505.

- (1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
- (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
  - (b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
  - (c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
  - (d) Have not within three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.
- (2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

South Dakota School of Mines & Technology

NAGW-3966

Organization Name

PR/Award Number or Project Name

Timothy G. Henderson, Director of Business & Administration

Name and Title of Authorized Representative

*Sharon L Reid for:*  
Signature

*03/08/1996*  
Date